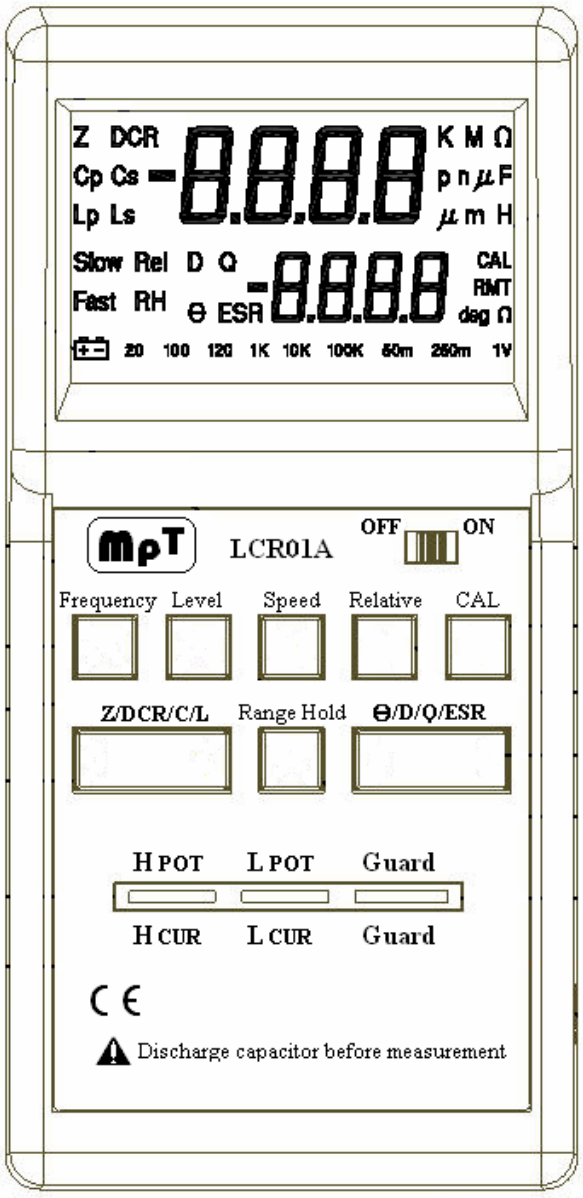
MPT LCR01A/B

Handheld LCR bridge meter

User manual



Featured：

1. Adapt DSP technology to achieve fast measuring speed, high accuracy and high reliability.Measuring frequency can be set at 100K/10K/1K/120/100/20 Hz (LCR01A) or 1M/500K/100K/10K/1K/100Hz(LCR01B)。
2. Measuring parameter：Main parameter　Z，Lp，Ls，Cp，Cs，DCR and subparameter ESR，D，Q，θ can be displayed in any combination.

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1. MPT LCR01A/B Introduction

1.1. Function introduction：

MPT LCR01A/B is an innovative AC/DC impedance meter，also include capacitance and inductance measurement。It differ from traditional meter，MPT LCR01A/B adapts DSP(Digital Signal Process) technique，Technicians and engineers will get various conveniences from this advanced meter。

Features of MPT LCR01A/B：

●Frequency：100K/10K/1K/120/100/20 Hz(LCR01A)
：1M/500K/100K/10K/1K/100Hz(LCR01B)

●Level：1Vrms/0.25Vrms/0.05Vrms/1.25Vdc(LCR01A)
：0.6Vrms/0.25Vrms/0.05Vrms/0.6Vdc(LCR01B)

- Measuring Parameter：Z，Lp，Ls，Cp，Cs，DCR，ESR，D，Q，θ
- Basic accuracy：0.2%(=＜10KHz)，0.4%(100KHz)，1%(500KHz)，2%(1MHz)
- Dual LCD display
- DSP fast measuring
- Auto range/Range hold
- Open/Short compensation
- Display parameters：

Z	：Impedance
DCR	：DC Resistance
Lp	：Inductance parallel
Ls	：Inductance series
Cp	：Capacitance parallel
Cs	：Capacitance series
θ	：Impedance phase angle
ESR	: Effective Series Resistance
D	：Dissipation factor
Q	：Quality factor

- Display assembly：

Serial mode： Z-θ , Z-ESR , Z-D , Z-Q
Cs-D , Cs-Q , Cs-θ , Cs-ESR

	Ls-D	, Ls-Q	, Ls-θ	, Ls-ESR
Parallel mode：	Cp-D	, Cp-Q	, Cp-θ	
	Lp-D	, Lp-Q	, Lp-θ	

1.2. Impedance parameter definition

According to the different measuring signal of impedance meter，It can be separated DC and AC impedance meter。The popular multimeter in market is a DC resistance meter；The MPT LCR01A/B is an AC/DC impedance meter。For electronic Circuit，component and material，impedance is an important parameter。

In engineering，vector is used to express impedance，It analysed real part Resistance(R) and imagine part reactance(X)；And the polar express impedance(Magnitude) and Theta(Phase)。Diagrams below show the relation。

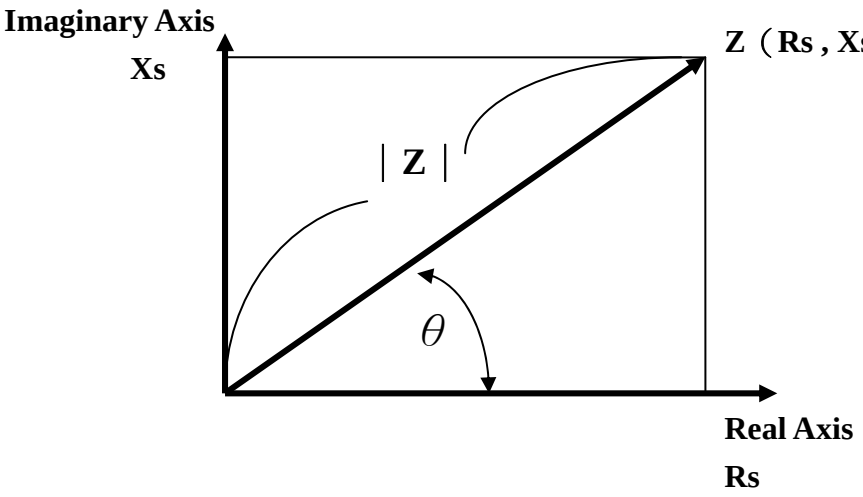


圖 一

Z = Rs+*j*Xs =｜Z｜∠θ（Ω）

Rs =｜Z｜Cosθ　　｜Z｜= $\sqrt{Rs^2 + Xs^2}$

Xs =｜Z｜Sinθ　　θ = Tan^{-1}（Xs/Rs）

Z：Impedance

Rs：Resistance

Xs：Reactance

Ω：Unit Ohm

Reactance can be separated as(Inductive) X_L and(Capacitive) X_C。The definition as：

$X_L = \omega L = 2\pi fL$

$X_C = (\omega C)^{-1} = (2\pi fC)^{-1}$

and L：Inductance (H)
C：Capacitance (F)
f：Frequency (Hz)

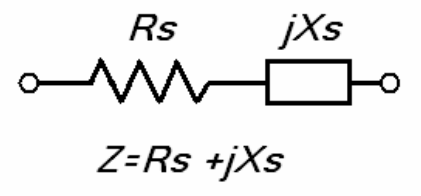
Additional，other parameters are attached to passive component，Quality factor(Q) and Dissipation Factor(D)。Both are defined the purity of reactance，that is the energy storage(reactance) and the energy consumption(resistance)ratio，defined as follow：

$$Q = D^{-1} = (\tan\delta)^{-1}$$
$$= |Xs| \cdot Rs^{-1} = \omega \cdot Ls \cdot Rs^{-1} = (\omega \cdot Cs \cdot Rs)^{-1}$$
$$= |B| \cdot G^{-1}$$
$$= Rp \cdot |Xs|^{-1} = Rp \cdot (\omega \cdot Lp)^{-1} = \omega \cdot Cp \cdot Rp$$

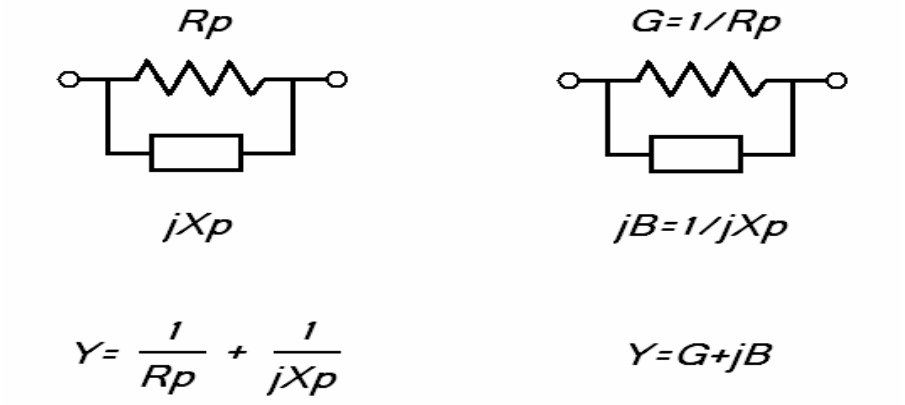
Quality factor is applied on inductive components，and Dissipation factor is applied on capacitive components。Both are reciprocal each other。

Traditional，component can be analysed as series equivalent and parallel equivalent。Both defined as follow。

Series connection



parallel connection



1.3. Specification and Accuracy

●LCD display：

parameter	Range
Z	0.000Ω ～ 9999MΩ
L	0.000μH ～ 9999H(LCR01A) 0.0xxnH ～ 9999H(LCR01B)
C	0.000pF ～ 9999F
DCR	0.000Ω ～ 9999MΩ
ESR	0.000Ω ～ 9999Ω
D	0.000 ～ 9999
Q	0.000 ～ 9999
Θ	- 180.0° ～ 180.0°

●Accuracy（Ae）：

|Zx| / Ae / Freq.	20M ∫ 10M (Ω)	10M ∫ 750K (Ω)	750K ∫ 100K (Ω)	100K ∫ 20K (Ω)	20K ∫ 10 (Ω)	10 ∫ 1 (Ω)	1 ∫ 0.1 (Ω)
DCR	2%±	1% ±	0.5%	0.2%	0.2%	0.5%±1	1% ± 1
20Hz(LCR01A)/100Hz	1*	1	±1	±1	±1	*	*
120Hz(LCR01A)							
1KHz							
10KHz	5%± 1*	2% ± 1					
100KHz	UnD	5% ± 1*	2% ± 1	0.4% ±1	0.4% ±1	2%±1*	5% ± 1 *
500KHz (LCR01B)	UnD	UnD	10% ±1	5% ± 1	1% ± 1	5%±1*	10%±1 *
1MHz (LCR01B)	UnD	UnD	UnD	10% ±1	2% ± 1	**10**%±1 *	20% ±1*

Accuracy show above is true when 1Vrms measuring level used。

Ae X 1.25 if 250mVrms measuring level used 。

Ae X 1.50 if 50mVrms measuring level used 。

measuring L and C，if Dx＞0.1, then Ae X $(1+Dx^2)$。

Measuring ESR，if Qx＞0.1, then Ae X $\sqrt{(1+Qx^2)}$ 。

＊ Measuring level set to 50mV, Ae undefined。

Z accuracy ：shown on table 1.

C accuracy ：

$$|Zx| = (2 \cdot \pi \cdot f \cdot Cx)^{-1} \quad (\Omega)$$

CAe＝Ae of ｜Zx｜

f：frequency(Hz)

Cx:The measured capacitance(F)

｜Zx｜：The measured impedance(Ω)

Above accuracy is true when Dx＜0.1，if D x＞0.1then CAe X $\sqrt{(1+Dx^2)}$。

Example：C accuracy calculate

Measuring condition：

Frequency：1KHz

Level：1Vrms

Speed：Slow

Capacitance under test：100nF

Then

$$|Zx| = (2 \cdot \pi \cdot f \cdot Cx)^{-1}$$

$$= (2 \cdot \pi \cdot 10^3 \cdot 100 \cdot 10^{-9})^{-1} = 1590\ (\Omega)$$

look up on table 1:

CAe＝±0.2 (%)

L accuracy ：

｜Zx｜＝2・π・f・L (Ω)

LAe＝Ae of ｜Zx｜

f：Frequency(Hz)

Lx:The measured inductance(H)

｜Zx｜：The measured impedance(Ω)

Above accuracy is true when Dx＜0.1，if D x＞0.1 then CAe X $\sqrt{(1+Dx^2)}$ 。

Example：L accuracy calculation

Measuring condition：

Frequency：1KHz

Level：1Vrms

Speed：Slow

Inductance under test：1mH

then

｜Zx｜＝2・π・f・Lx

＝2・π・10^3・10^{-3}＝6.283 (Ω)

look up on table 1:

LAe＝±0.5 (%)

ESR accuracy ：

$$\pm Xx \cdot Ae \cdot 100^{-1} \quad (\Omega)$$

$$Xx = 2 \cdot \pi \cdot f \cdot Lx = (2 \cdot \pi \cdot f \cdot Cx)^{-1}$$

f：Frequency(Hz)
Xx:The measured impedance(Ω)
Lx:The measured inductance(H)
Cx：The measured capacitance(F)

Above accuracy is true when Dx＜0.1。
Example：Cs-ESR accuracy calculation
Measuring condition：
Frequency：1KHz
Level：1Vrms
Speed：Slow
Capacitance under test：100nF
then

$$|Zx| = Xx = (2 \cdot \pi \cdot f \cdot Cx)^{-1}$$

$$= (2 \cdot \pi \cdot 10^{3} \cdot 100 \cdot 10^{-9})^{-1} = 1590\ (\Omega)$$

look up on table 1:
CAe＝±0.2 (%)

$$ESR_{Ae} = \pm Xx \cdot Ae/100$$

$$= \pm 1590 \text{ X } 0.2 / 100 = \pm 3.18 \quad (\Omega)$$

D accuracy ：

$$De = \pm A_e / 100$$

Above accuracy is true when Dx＜0.1，if D x＞0.then CAe X (1+Dx)。

Example：C-D accuracy calculation

Measuring condition：

Frequency：1KHz

Level：1Vrms

Speed：Slow

Capacitance under test：100nF

then

$$|Zx| = (2 \cdot \pi \cdot f \cdot Cx)^{-1}$$

$$= (2 \cdot \pi \cdot 10^{3} \cdot 100 \cdot 10^{-9})^{-1} = 1590\ (\Omega)$$

look up on table 1:

$CAe = \pm 0.2\ \ (\%)$

$$D_{Ae} = \pm CAe / 100$$

$$= \pm 0.2/100 = \pm 0.002$$

Q accuracy ：

$$Qe = \pm(Qx^2 \cdot De)/(1 \mp Qx \cdot De)$$

Qx：The measured Q value。

De:relative D accuracy。

Above accuracy is true when $Qx \cdot De < 1$。

Example：C-Q accuracy calculation

Measuring condition：

Frequency：1KHz

Level：1Vrms

Speed：Slow

Inductance under test：1mH

then

$$|Zx| = 2 \cdot \pi \cdot f \cdot Lx$$

$$= 2 \cdot \pi \cdot 10^3 \cdot 10^{-3} = 6.283\ (\Omega)$$

look up on table 1:

LAe＝±0.5 (%)

De＝±Ae/100＝±0.005

If the measured Qx＝20

$$QAe = \pm(Qx^2 \cdot De/(1 \mp Qx \cdot De)) = \pm\ (2/(1 \mp 0.1))$$

Θ accuracy ：

$\theta e = (180/\pi)/(Ae/100)$ (Deg)

Example：Z-θ accuracy calculation

Measuring condition：

Frequency：1KHz

Level：1Vrms

Speed：Slow

Capacitance under test：100nF

then

$$|Zx| = (2 \cdot \pi \cdot f \cdot Cx)^{-1}$$

$$= 1/(2 \cdot \pi \cdot 10^{3} \cdot 100 \cdot 10^{-9}) = 1590\ (\Omega)$$

look up on table 1:

$ZAe = \pm 0.2$ (%)

$\theta Ae = \pm(180/\pi)/(ZAe/100) = \pm 0.115$ (Deg)

●measuring signal：

Level accuracy：10%

Frequency accuracy：0.01%

●Output impedance：100Ω±5%

●Measuring speed：depend on frequency

Fast： 5 times/second(1 0 KHz)

Slow： 2 ． 5 times/second(1 0 KHz)

●Power low notify：

Input or battery power lower than 6.2Volt

●Battery：

Charge current：about 18mA

Battery type：Ni-Mh

Life：3.0 hr(LCR01A) ，1.5 hr(LCR01B)

●Adapter：

Input：110V/220Vac 50/60Hz

Output：12Vdc

●Operation environment：

Temperature：0℃ to 40℃ (operation)

-20℃ to 70℃ (storage)

Humidity：≦85% R.H. at 40℃

Size：178mm × 86 mm × 45mm

7” × 3.4” × 1.8” (L×W×H)

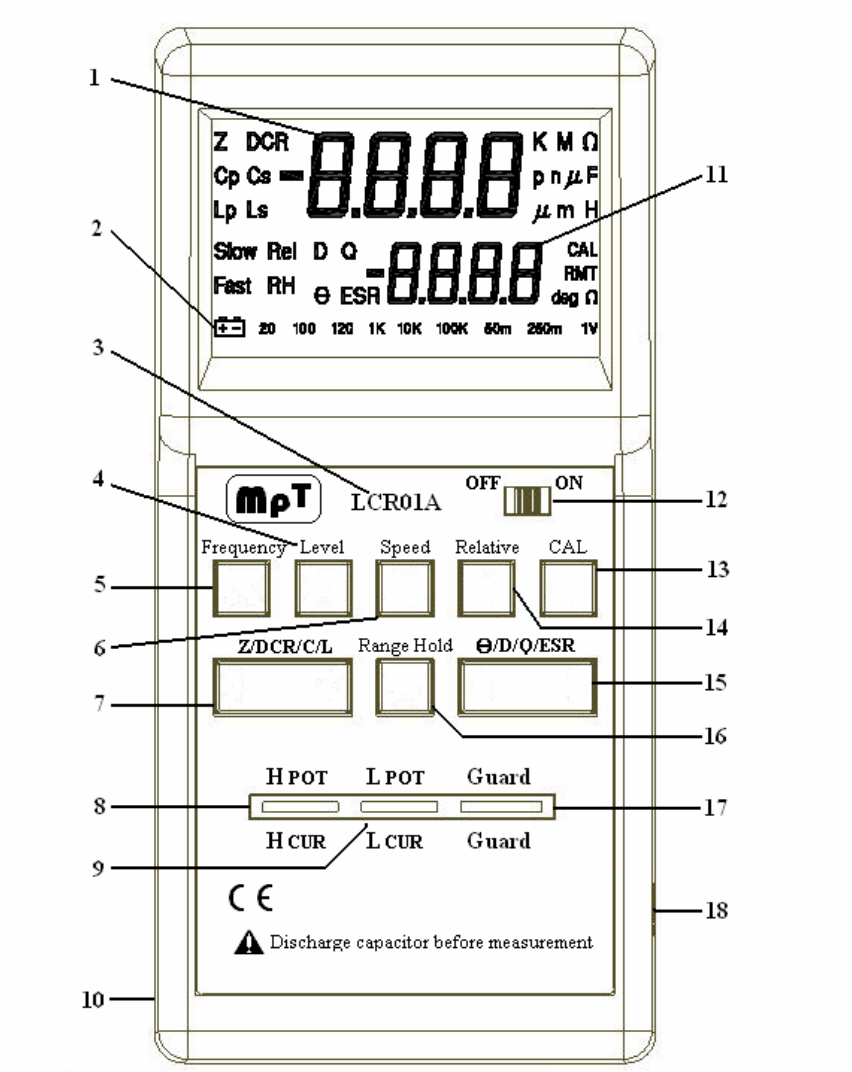
Weight：300g

1.4. Accessory

- ●LCR01A/B Operation manual
- ●LCR01A or **LCR01B** one set
- ●Ni-Mh rechargeable battery
- ●Shorted Bar
- ●5 wire/0.75mSMD test probe
- ●5 wire/0.75m Kelvin Clips test cable
- ●AC power adaptor

2. User operate illustration

2.1. Panel：

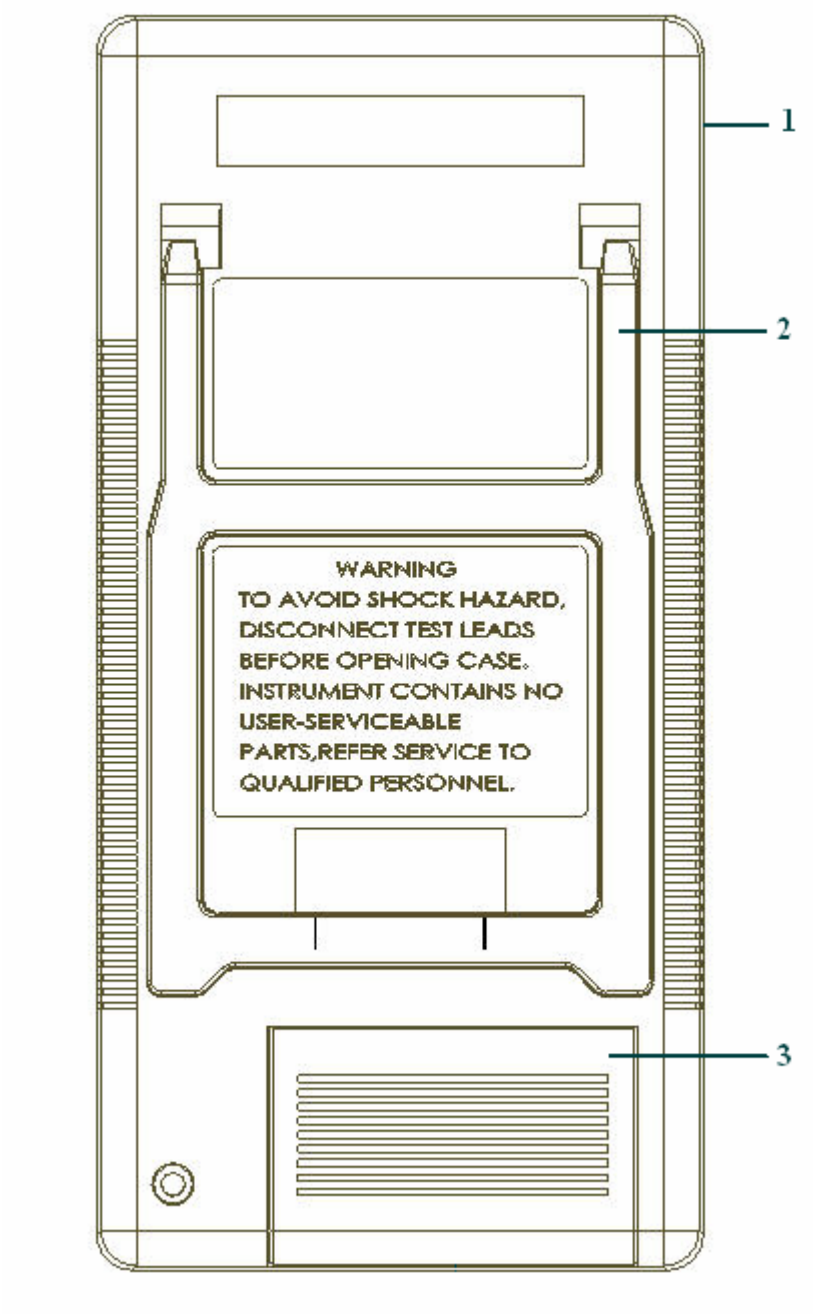


1. Main parameter display LCD
2. Low voltage indicator
3. Machine type
4. Level switch button
5. Frequency switch button
6. Display speed switch Button
7. Z/DCR/C/L display switch button
8. Hpot/Hcur terminal
9. Lpot/Lcur terminal
10. Battery house
11. Subparameter display LCD
12. Power ON/OFF switch
13. Open/Short calibration button
14. Relative mode button
15. θ/D/Q/ESR display switch button
16. Auto/Range hold switch button
17. Guard terminal
18. Power adaptor input hole

2.2. Power：

●Battery supply

Remove battery cup，clean battery house，put the pull-up tape under battery and put battery into the battery house in proper direction，then put on the battery cup。If the battery is not chargeable，remove the power adaptor input connector；If the battery is chargeable，power adaptor input connector can be plug-in。



●Power adaptor supply

If battery not available，It can be powered by power adaptor。If the power adaptor is plug-in and the power switch on LCR01A/B is off，It will charge battery on battery house。

2.3. Open/Short calibration：

LCR01A/B function with Open/Short calibration to meet the measuring of High/Low impedance measurement。

●Open calibration

Clean the measuring terminal，make it on open state，press【CAL】button about 1 second，main parameter will display「CALO」and a “bi” sound will be heard，Calibration time will depend on measuring frequency，the high frequency，the lower calibration time needed；After calibration，a “bi” sound will be heard again。

●Short calibration

Plug-in shorted bar first，press【CAL】about 2 seconds，till「CALS」shown on main display，and a “bi” sound will be heard；After calibration，a “bi” sound will be heard again。

2.4. ●Display refresh：

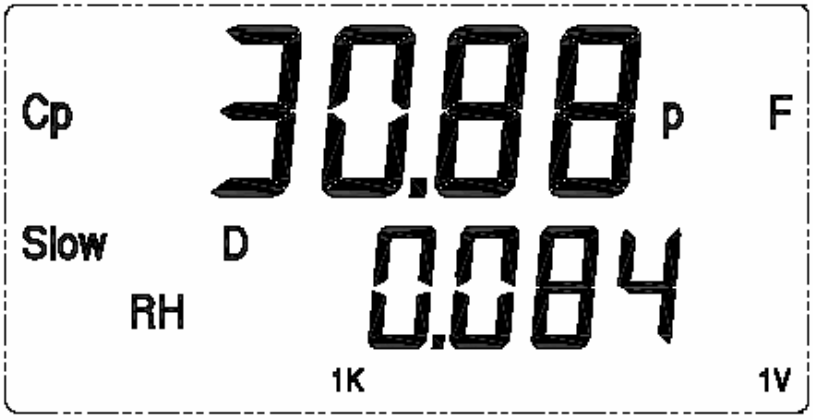
LCR01A/B functions with Fast/Slow display refresh mode，User press the 【Speed】button will toggle speed mode。on『Fast』mode，the refresh speed will be twice of『Slow』mode，the more of the measuring frequency，the faster of the refresh speed。

2.5. ●Relative mode

LCR01A/B functions with measuring relative mode，user put a reference component on the test terminals。Then press 【Relative】button。And remove this reference component from the test terminals，put other device under test on test terminals then，the main LCD display will display the result of subtraction of the reference value from the measuring one。

2.6. ●Range hold mode

LCR01A/B functions with autorange/range_hold mode，put a reference component on the test terminals，then wait until display stable，press【Range Hold】button。『RH』will be shown on sub-parameter display LCD，LCR01A will set this measuring range。Remove this reference component and put other component under test on test terminals，the measured result will gotten faster。But care should be taken，the measured range should in the range 2 and 1/2 of the reference value。

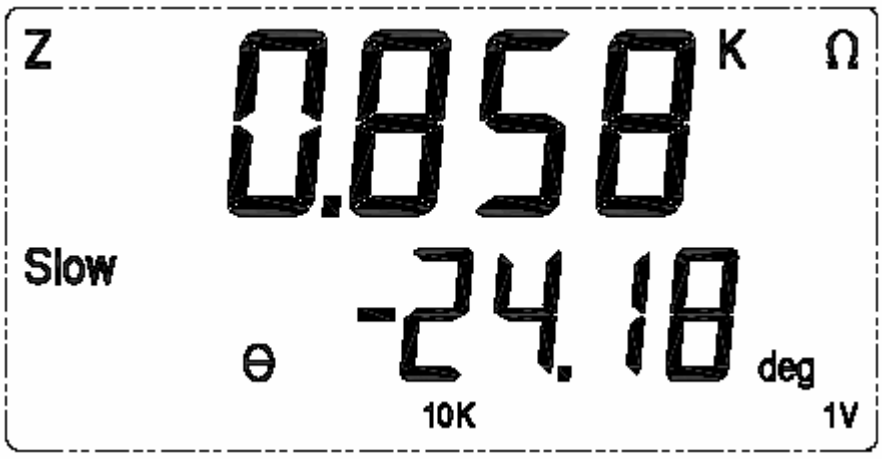


2.7. ●DC impedance measuring

Press【L/C/Z/DCR】，till『DCR』shown on main parameter display LCD，then LCR01A/B will be in the DC impedance measuring mode。

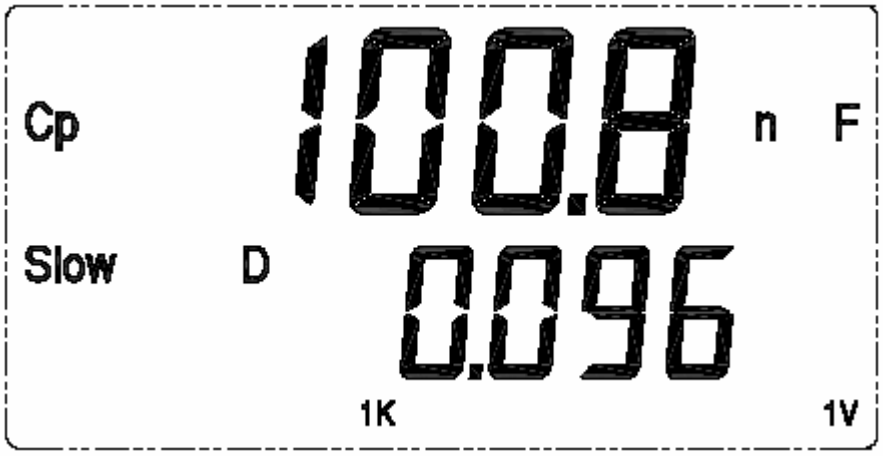
2.8. ●AC impedance measuring

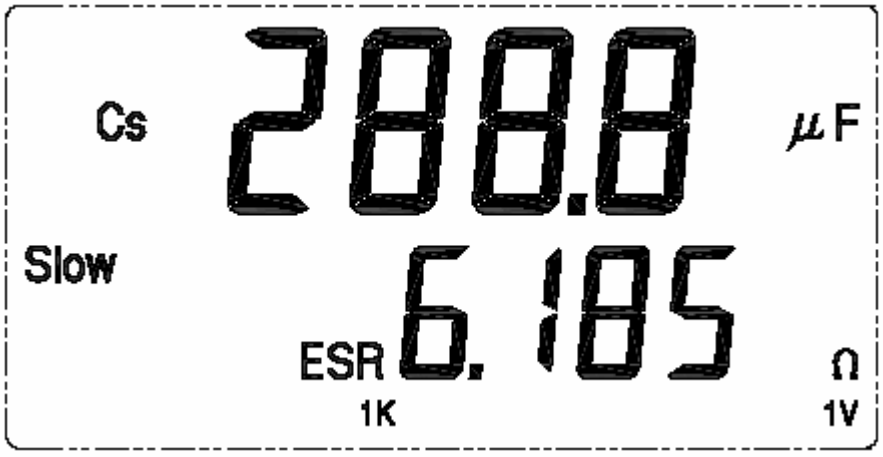
Press【L/C/Z/DCR】，till『Z』shown on main parameter display LCD，then LCR01A/B will be in the AC impedance measuring mode。



2.9. ●Capacitance measuring

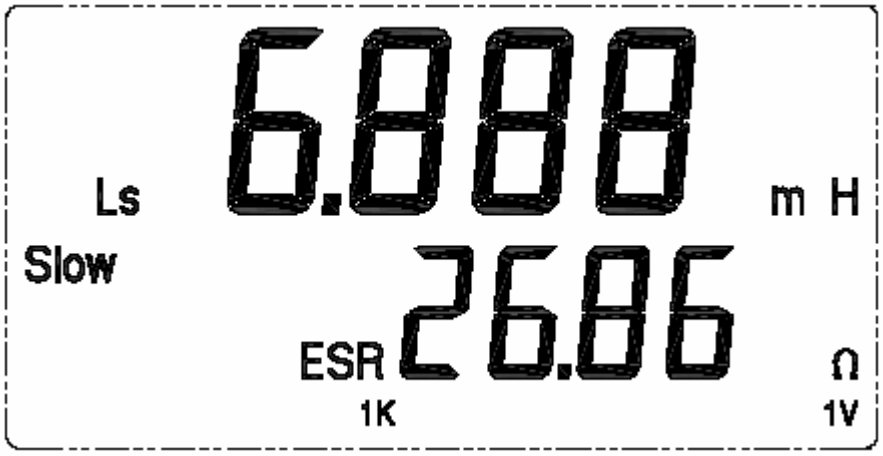
Depend on component equivalent，Capacitance measuring can be separated as(Cs，Serial Mode) and (Cp，Parallel Mode)，user can press【L/C/Z/DCR】button as they need。If 『Cs』mode selected，then press button【θ/D/Q/ESR】select one of the four θ/D/Q/ESR sub-parameter。If『Cp』mode selected，then press button【θ/D/Q/ESR】select one of the three θ/D/Q sub-parameter。





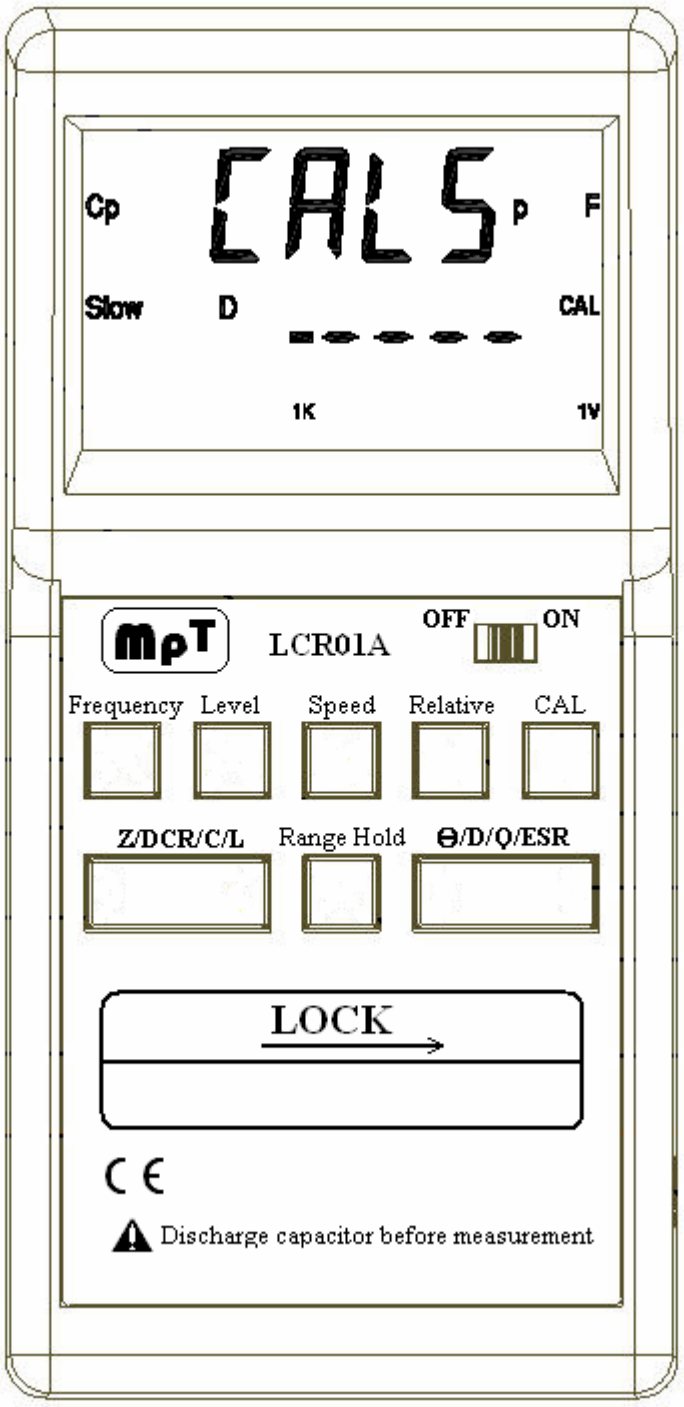
2.10. ●Inductance measuring

Inductance measuring can be separated as(Ls，Serial Mode) and (Lp，Parallel Mode)，user can press【L/C/Z/DCR】button as they need。If『Ls』mode selected，then press button【θ/D/Q/ESR】select one of the four θ/D/Q/ESR sub-parameter。If『Lp』mode selected，then press button【θ/D/Q/ESR】select one of the three θ/D/Q sub-parameter。。

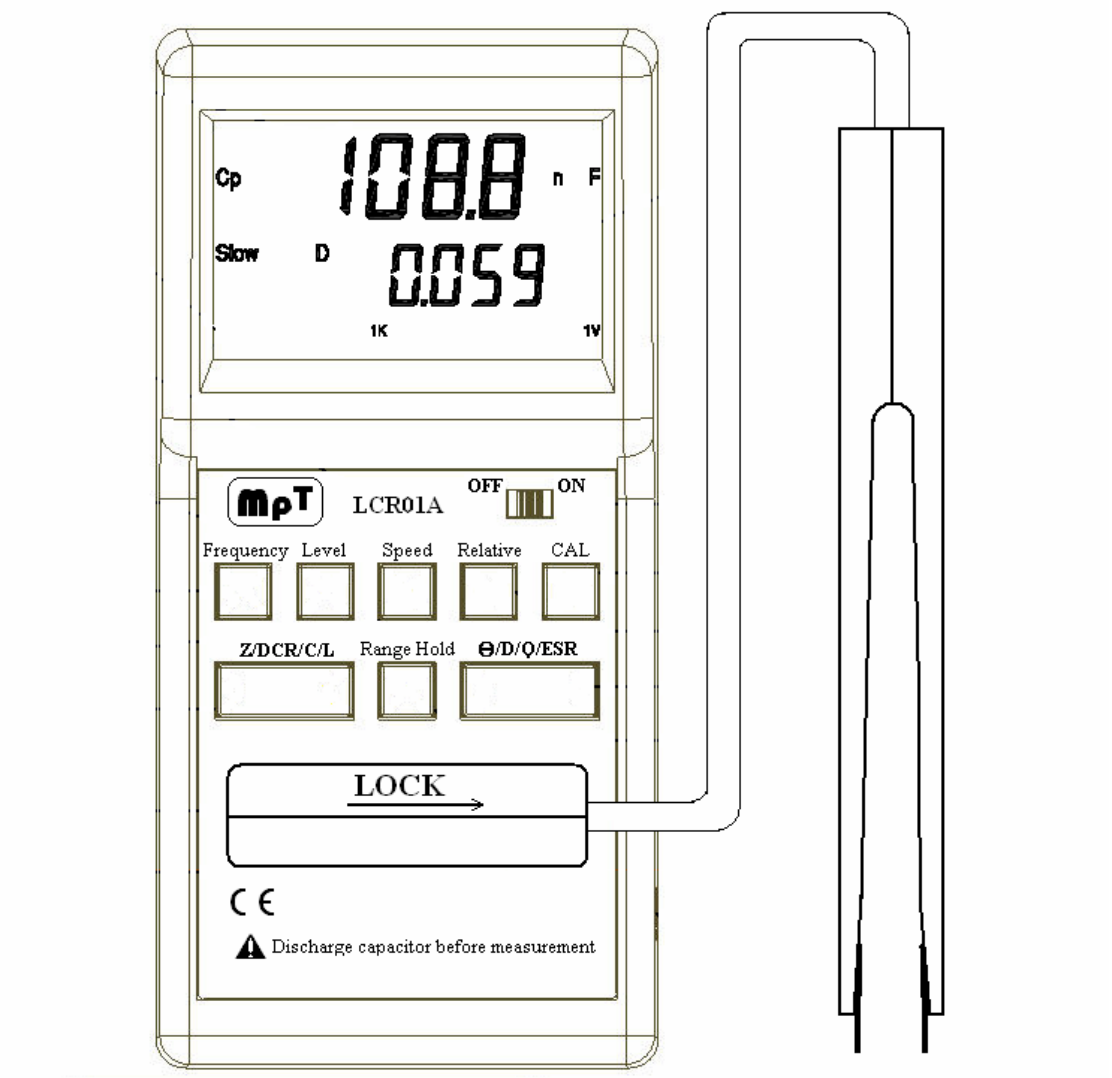

6.888
Ls
m H
Slow
26.86
ESR
Ω
1K
1V

2.11. ●Accessory operation

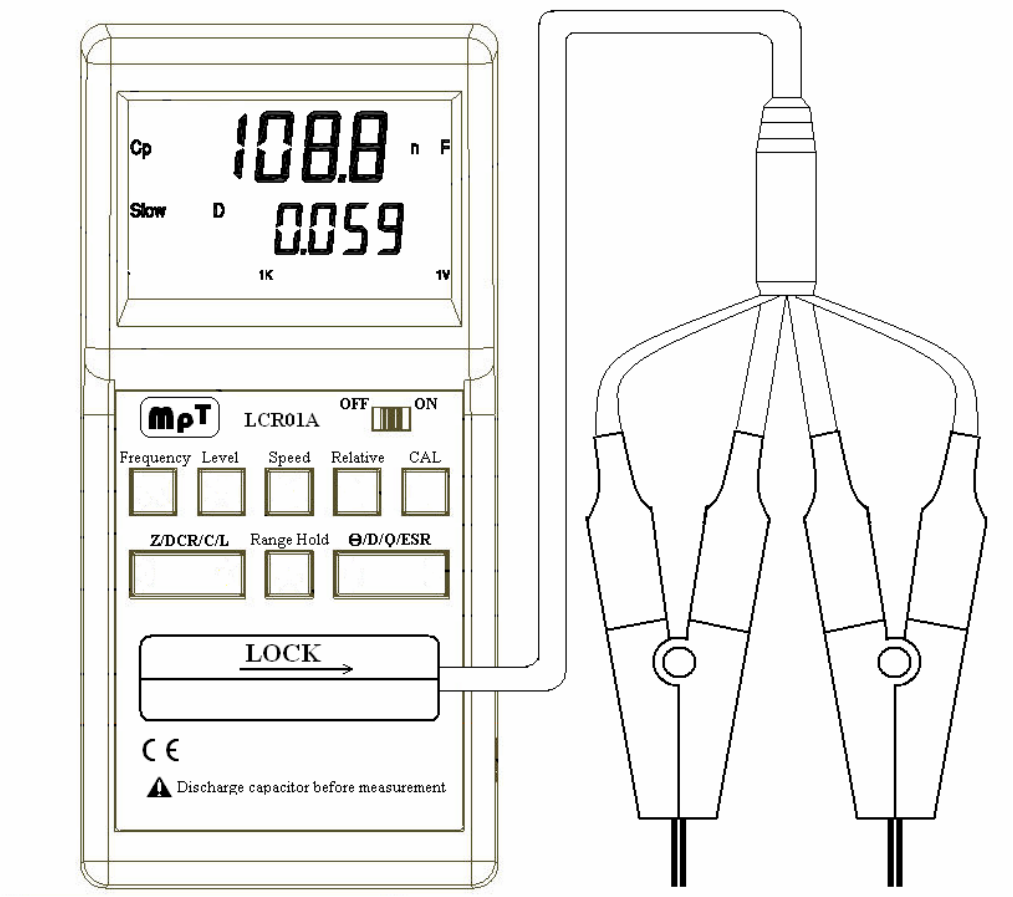
To insure measuring accuracy and stable，perform「LOCK」action when test probe been used。



Shorted Bar



SMD Test Probe



Kelvin Clip Test Probe

3. Use noted

3.1. Service information

MPT warrants to the original purchaser that its products and the component thereof ，will be free from defects in workmanship and materials for a period of one year from date of purchase。

3.2. Items notes

●Don’ t open the device case beside battery cap。

●Keep measuring terminals clean to insure measuring accuracy。

●During measuring，keep hands away form device above 10cm。

●Discharge capacitor before measuring。

●When low voltage alarm，then replace battery or charge with adaptor。

●Remove battery if long period don’ t use。

Appendix Cable connection technique

一

Auto-balancing Bridge has four terminals(Hcur、Hpot、Lcur、and Lpot)to connect the device under test(DUT).It is important to understand what connection method will affect the measurement accuracy。

Two terminal(2T)is the simplest way to connect the DUT，but it contents many errors which are the inductor and resistor as well as the parasitic capacitor of the test leads(figure 1)。Due to these errors in measurement，The effective impedance measurement range will be limit at 100Ωto 10KΩ。

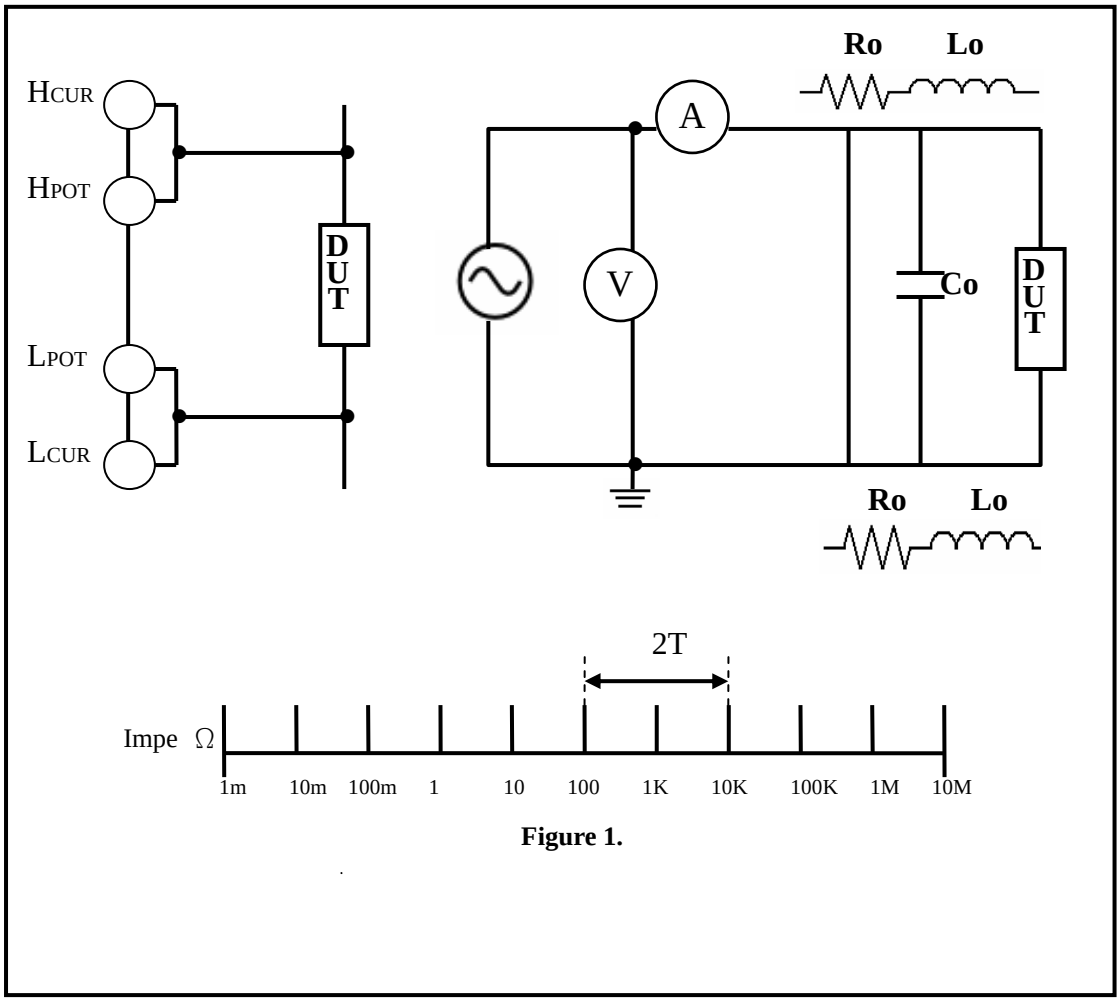

HCUR
HPOT
LPOT
LCUR
DUT
A
V
Ro
Lo
Co
DUT
Ro
Lo
2T
Impe Ω
1m
10m
100m
1
10
100
1K
10K
100K
1M
10M

Figure 1.

3-Terminals(3T) uses coaxial cable to reduce the effect of the parasitic capacitor，the shield of the coaxial cable should be connect to Guard of the instrument to increase the measurement range up to 10 MΩ。

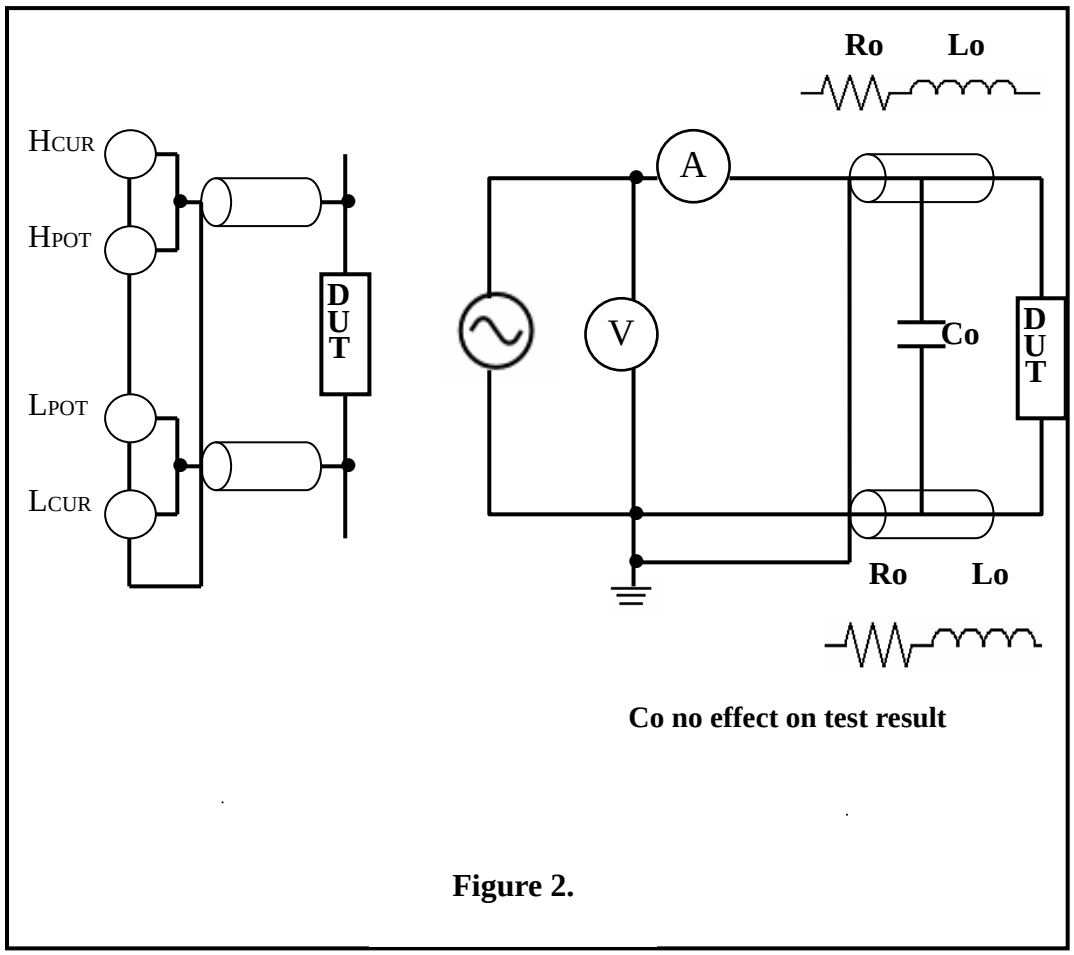


Figure 2.

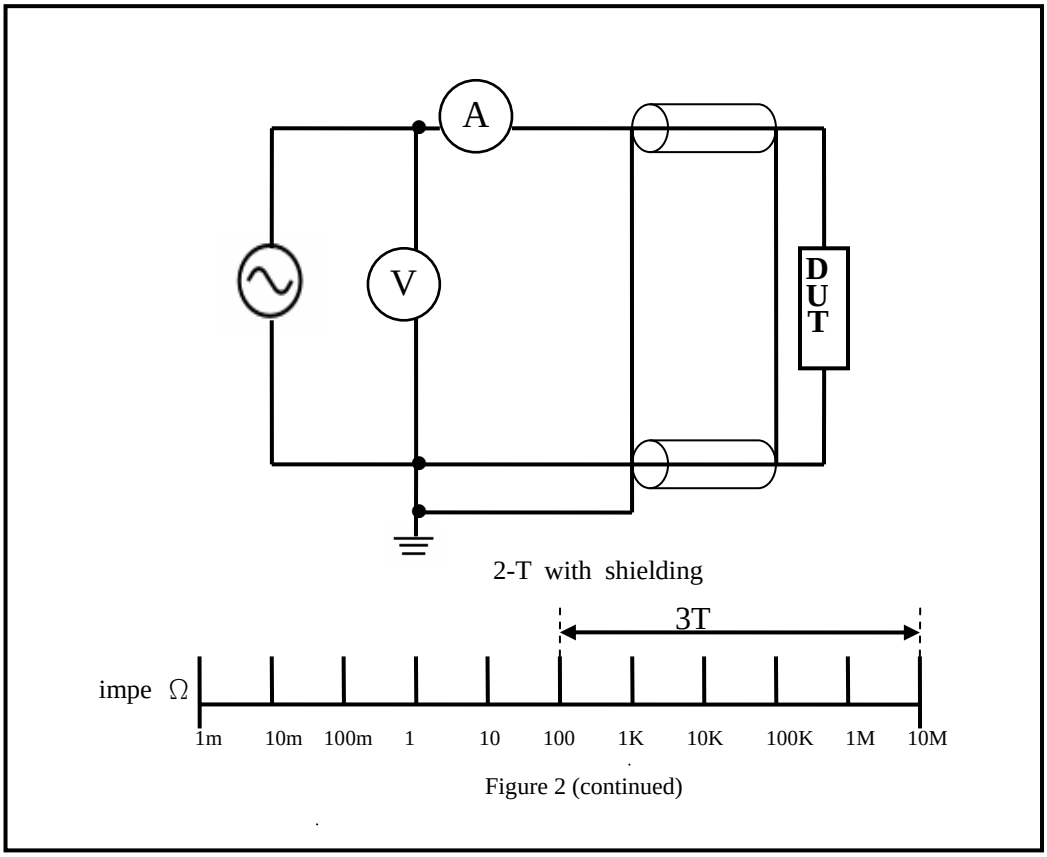


Figure 2 (continued)

4-Terminal(4T)connection reduces the effect of the test lead resistance，this connection can improve the measurement range down to 10mΩ。However，the inductance of the test lead can not be eliminated。

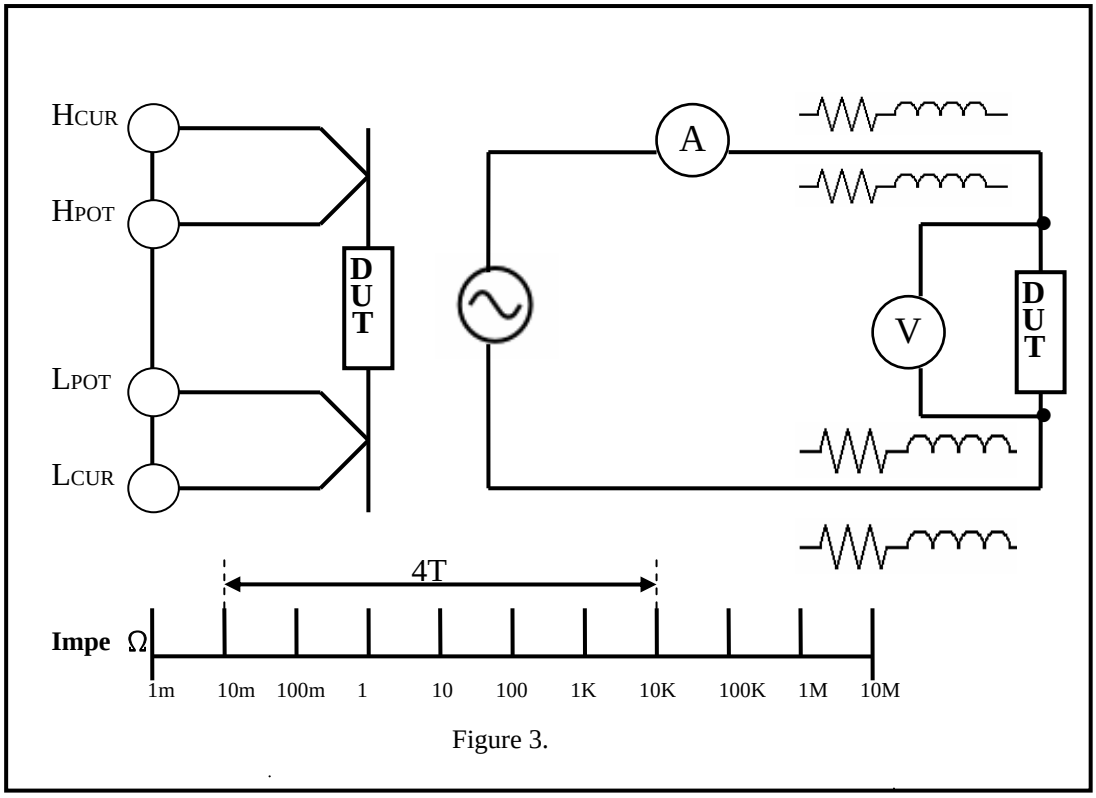
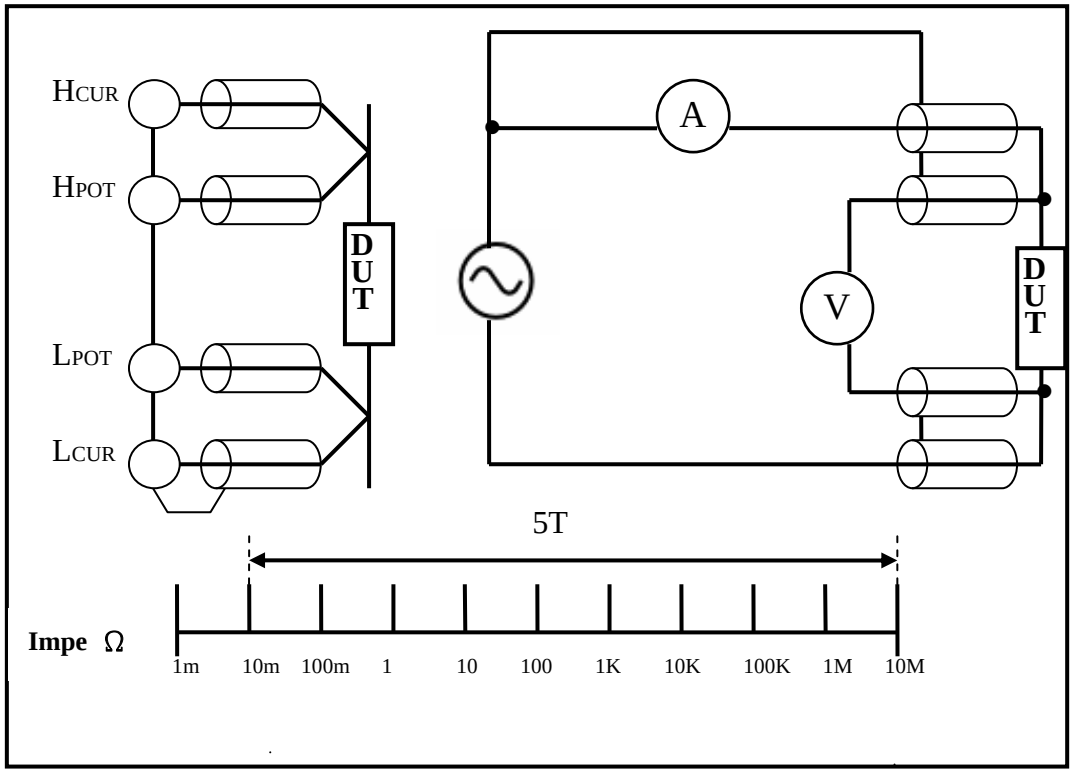
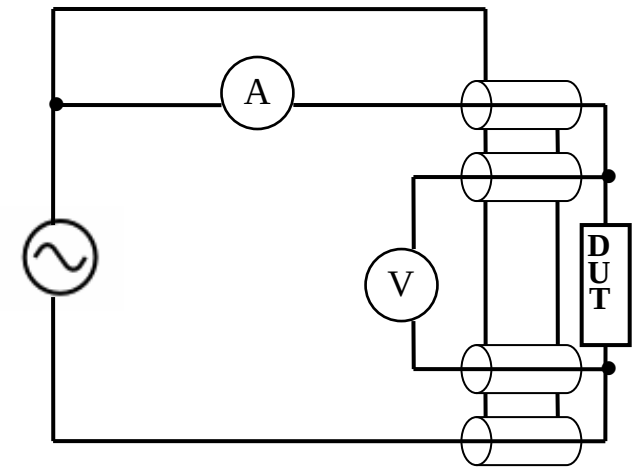


Figure 3.

5-Terminal connection is the combination of 3T and 4T。It has four coaxial cable。Due to the advantage of 3T and 4T，this connection can widely increase the measurement range for 10mΩ to 10MΩ。



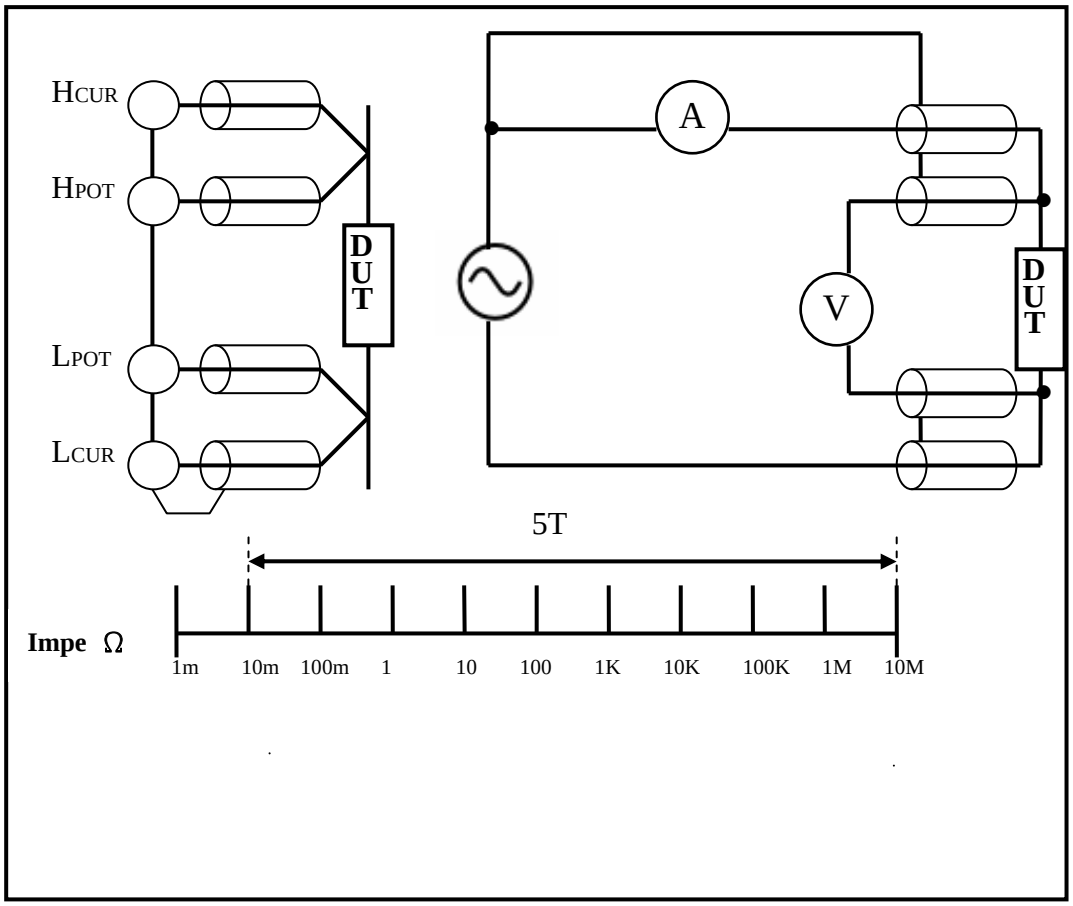


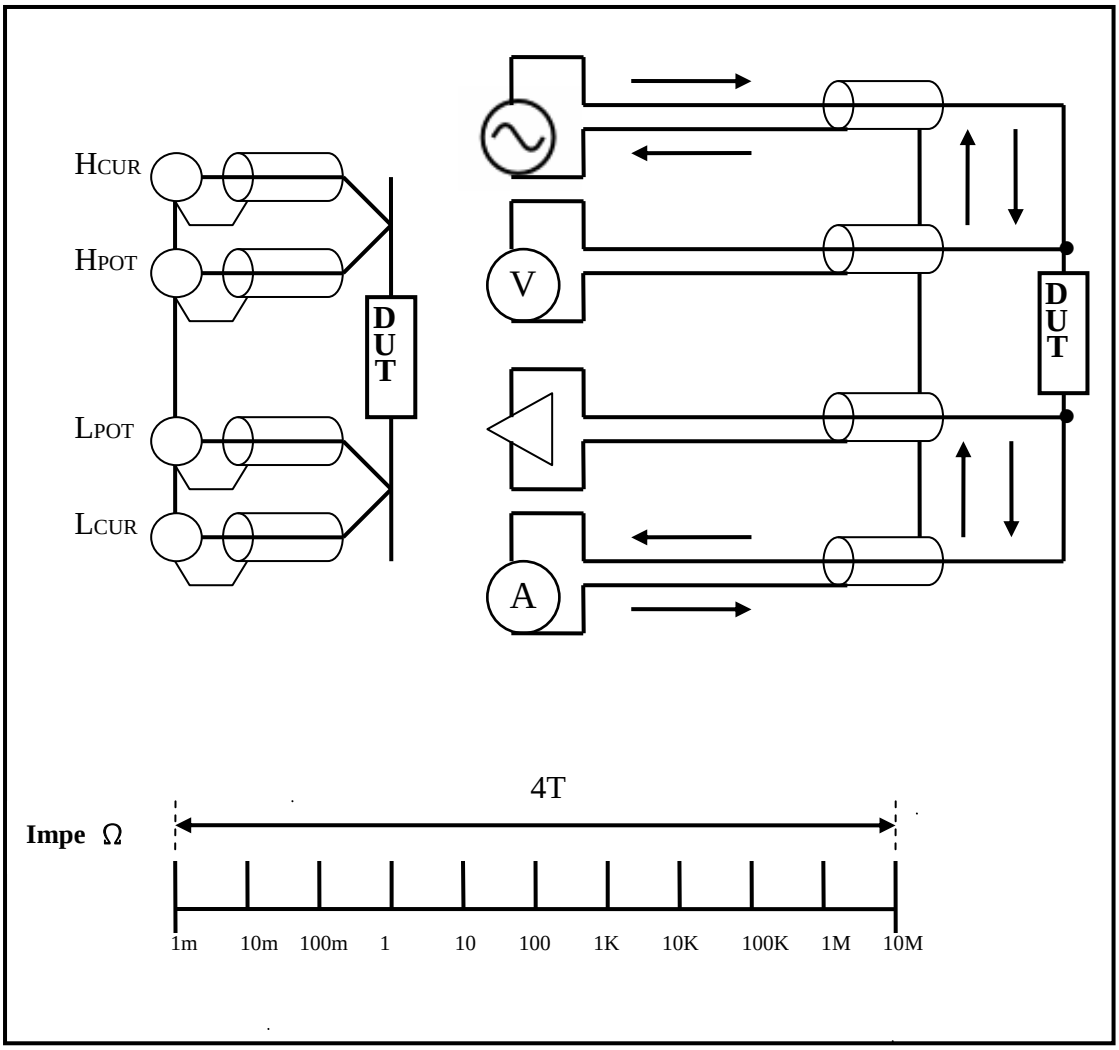
Wrong connection of 4T

Figure 4.

4-terminal path(4TP) connection solves the problem that caused by the test lead inductance。4TP uses four coaxial cables to isolate the current path and the voltage sense cable。The return current will flow through the coaxial cable as well as the shield

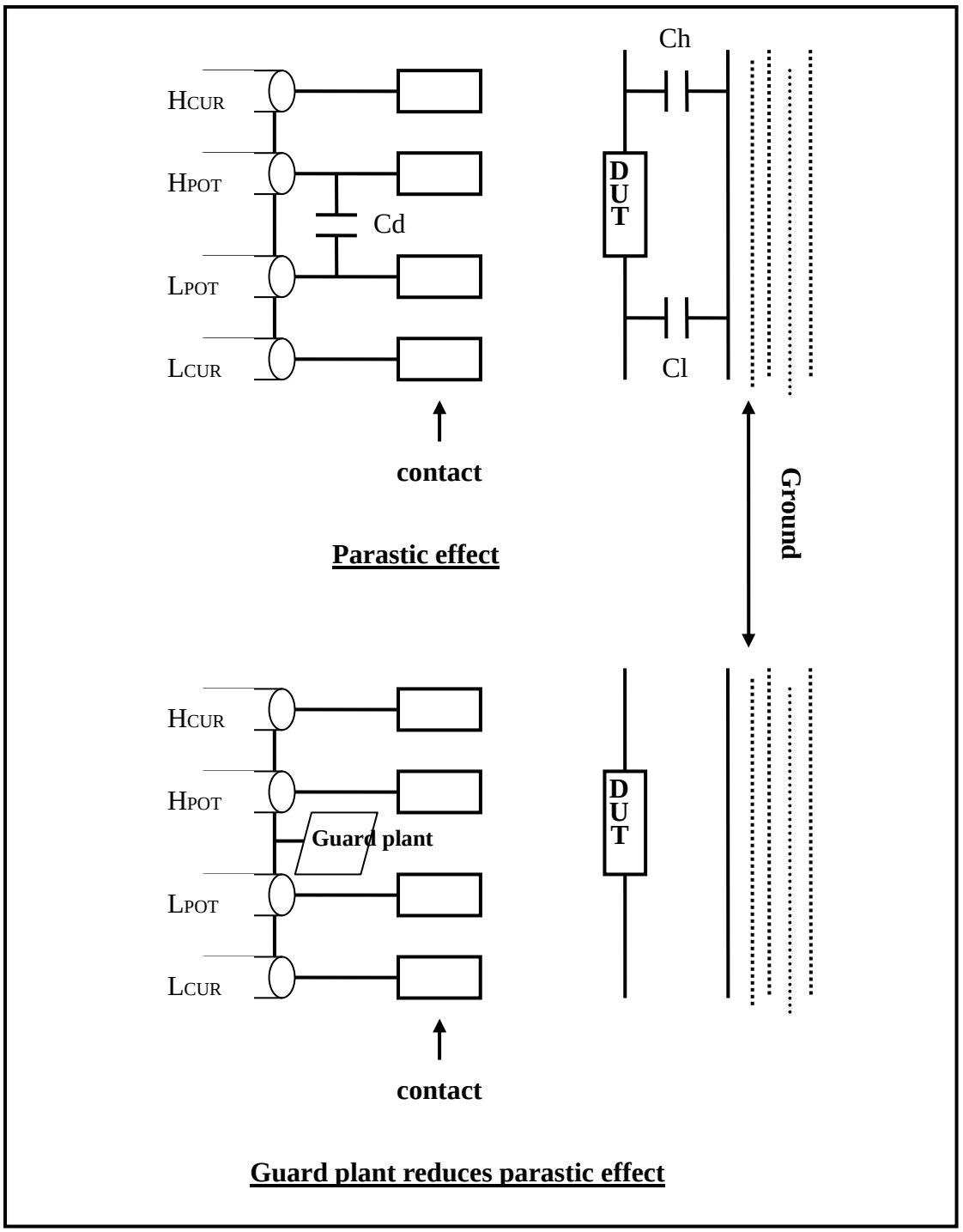
。Therefore，the magnetic flux that generated by internal conductor will cancel out the magnetic flux generated by external conductor(shield)。The 4TP increase the measurement range from 1mΩ to 10MΩ。


HCUR
HPOT
LPOT
LCUR
DUT
A
V
DUT
5T
Impe Ω
1m
10m
100m
1
10
100
1K
10K
100K
1M
10M


HCUR
HPOT
LPOT
LCUR
DUT
V
A
DUT
4T
Impe Ω
1m
10m
100m
1
10
100
1K
10K
100K
1M
10M

Eliminating the effect of the parasitic capacitor

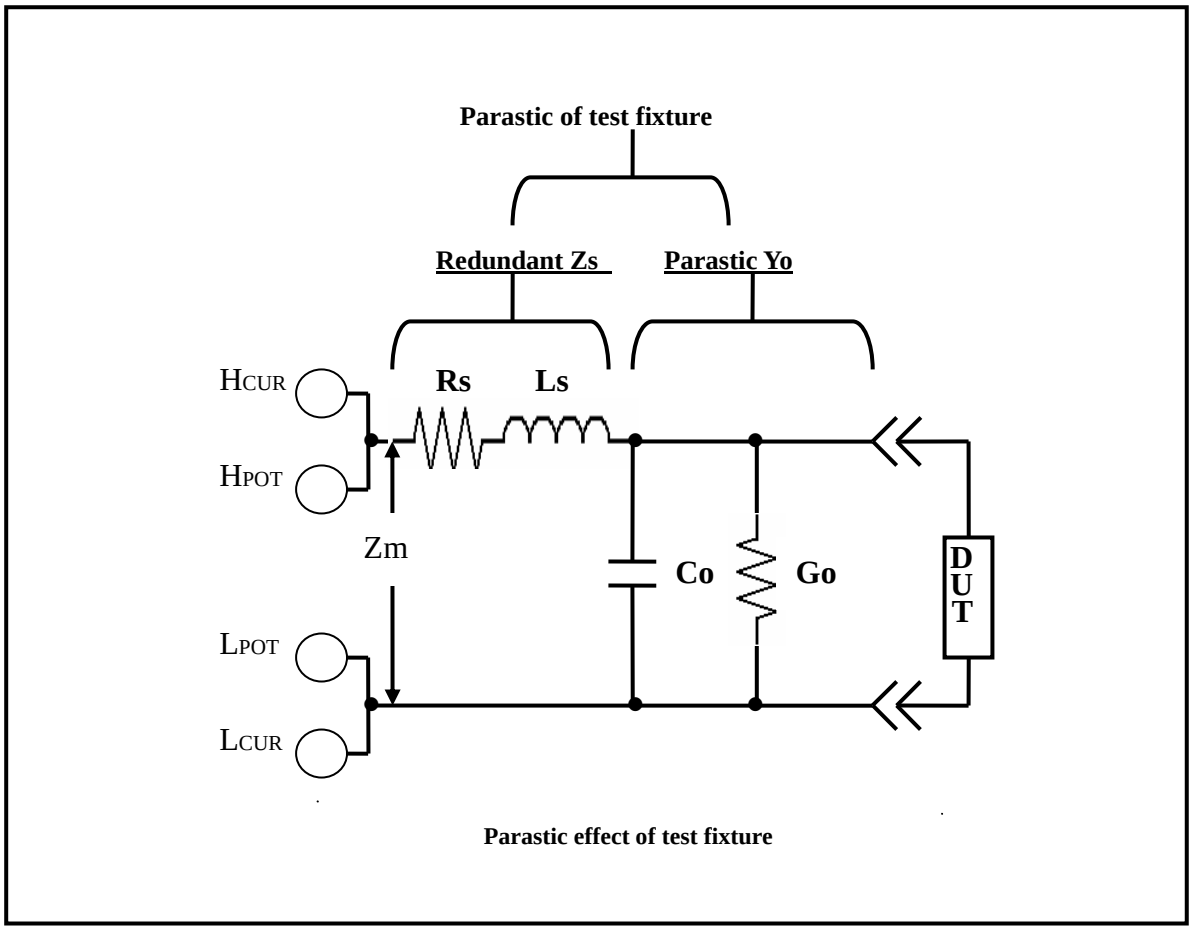
When measuring the high impedance component(i.e. low capacitor)，the parasitic capacitance becomes an important issue(Figure 3.6)。In figure 3.6(a)，the parasitic capacitor Cd is paralleled to DUT as well as Ci and Ch，To correct this problem。Add a guard plane(Figure 3.6b) in between H and L terminals to break the Cd。If the guard plane is connected to instrument guard，The effect of Ci and Ch is removed。

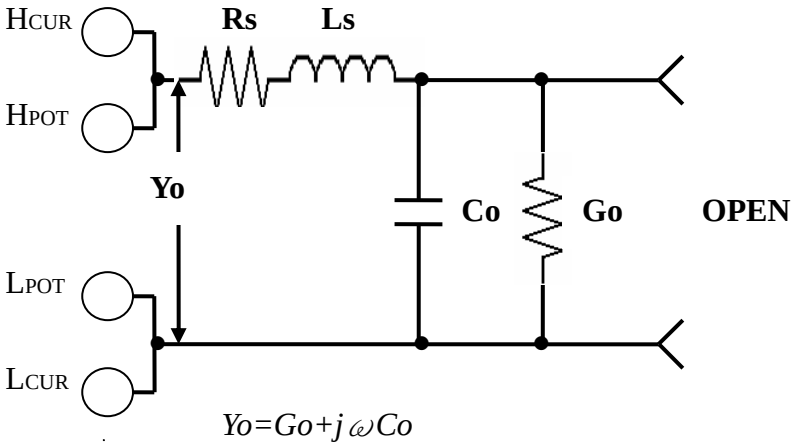


Append　Open/Short compensation

2

For those precision impedance measuring instrument，the open and short compensation need to be used to reduce the parasitic effect of the test fixture。The parasitic effect of the test fixture can be treated like the simple passive components in figure 3.7a。When the DUT is open，the instrument gets the conductance Yp=Gp+jwCp(Figure 3.7b) 。When the DUT is short，the instrument gets the impedance Zs=Rs+jwLs(Figure 3.7c)。After open and short compensation，Yp and Zs are for calculating the real Zdut(Figure 3.7d)。

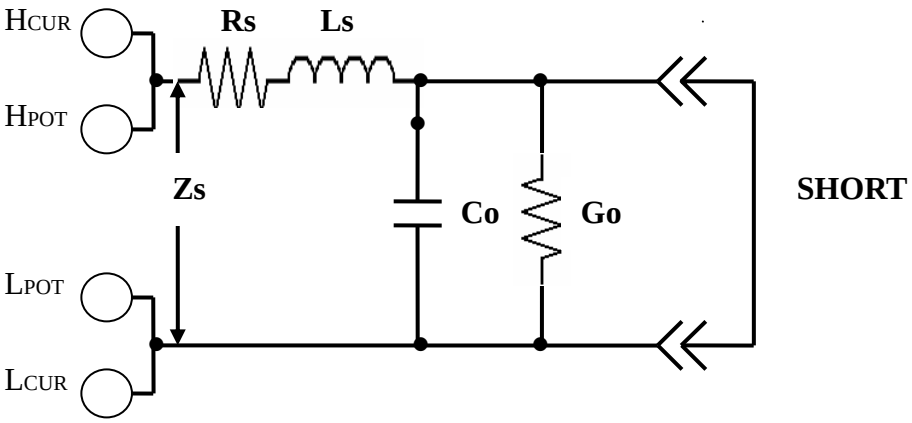




$Yo = Go + j\omega Co$

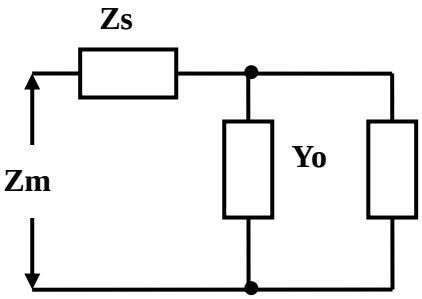
$Rs + j\omega \ll (Go + j\omega Co)^{-1}$

Open ckt



$Zs = Rs + j\omega Ls$

Short ckt



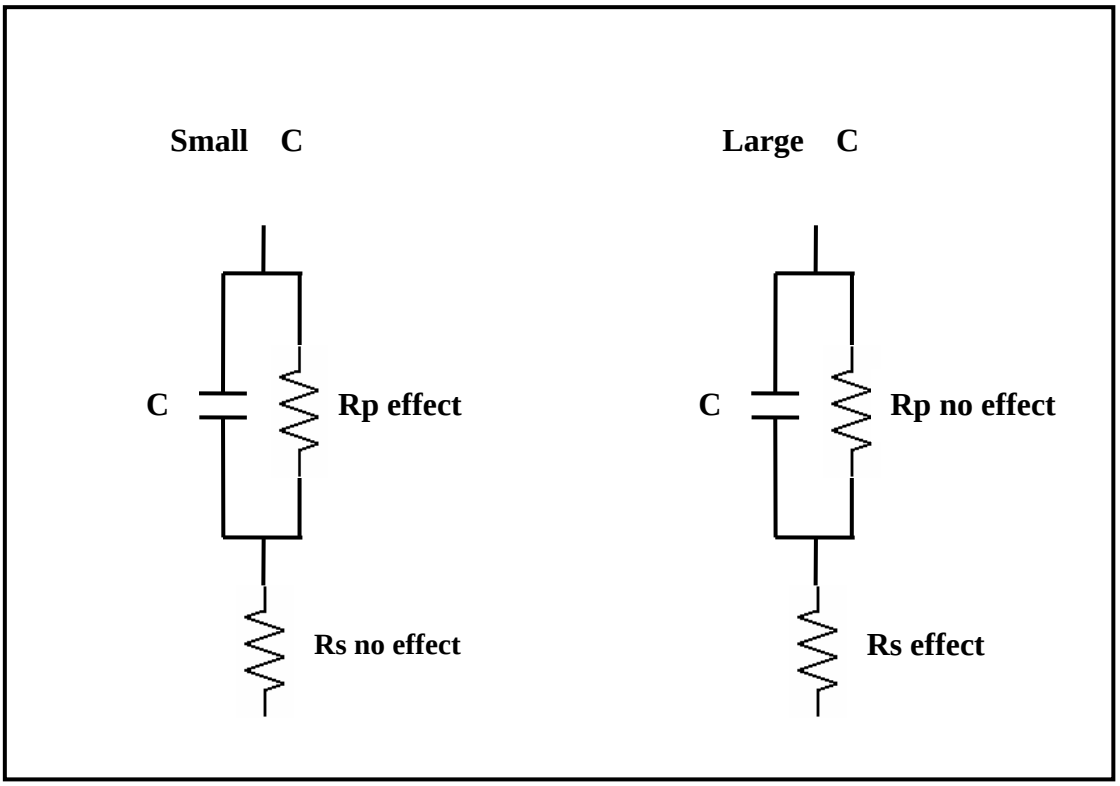
$$Zdut = \frac{Zm - Zs}{1 - (Zm - Zs)Yo}$$

Appendi x 3 Selecting the series or parallel mode

According to different measuring requirement，there are series and parallel modes to describe the measurement result。It is depending on the high or low impedance value to decide what mode to be used。

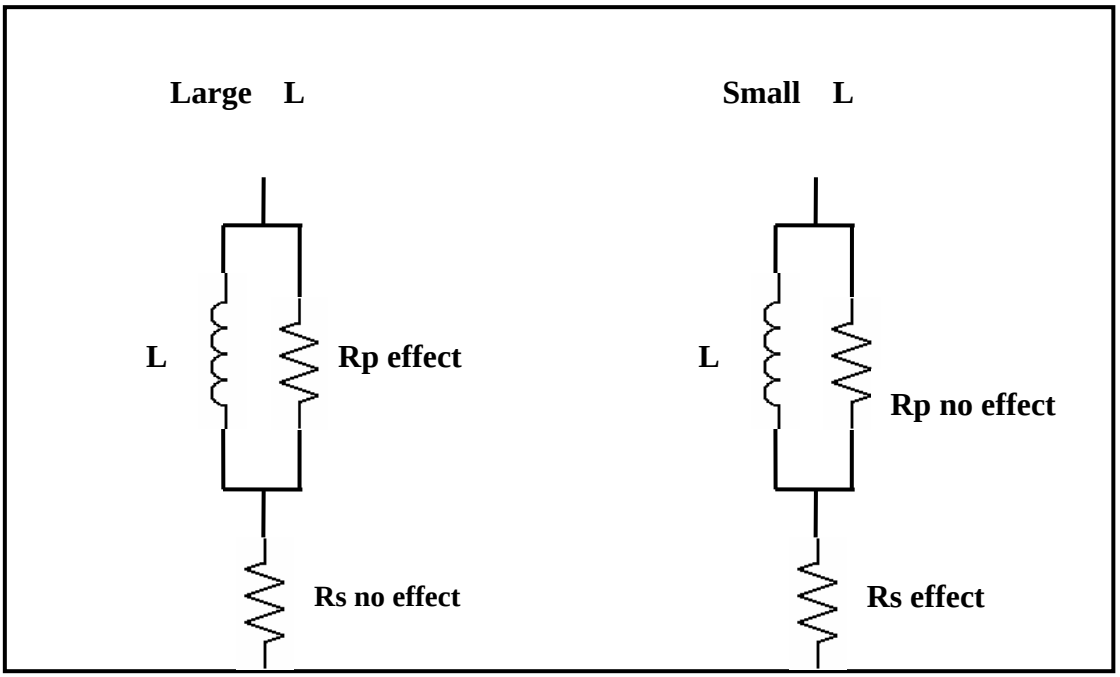
●capacitor

The impedance and capacitance in the capacitor are negatively proportional。Therefore，the large capacitor means the low impedance；the small capacitor means the high impedance。Figure below shows the equivalent circuit of capacitor。If the capacitor is small，the Rp is more important than the Rs。If the capacitor is large，the Rs shouldn't be avoided。Hence，uses parallel mode to measure low capacitor and series mode to measure high capacitor。



●Inductor

The impedance and inductive in the inductor are positively proportional。Therefore，the large inductor equals to the high impedance and vice versa。Figure below shows the equivalent circuit of inductor。If the inductor is small，the Rs is more important than Rp，If the inductor is large，The Rp should be taking care of。So，uses series mode to measure low inductor and parallel mode to measure high inductor。



According to analysis above：

1. Impedance below 10Ω，series mode selected。
2. Impedance above 10KΩ，parallel mode selected。
3. Between 10Ω and 10KΩ depend on needed。

Example：

DUT=100pF
Freq.=10KHz
Z=159.2KΩ
parallel mode selected。

Example：

DUT=100μH
Freq.=10KHz
Z=6.2832Ω
Serial mode selected。

C. Accuracy：

20Hz	398 pF ∫ 795.5 pF	795.5 pF ∫ 10.6 nF	10.6 nF ∫ 79.55 nF	79.55 nF ∫ 795.5 μF	795.5 μF ∫ 7.955 mF	7.955 mF ∫ 79.55 mF
	2%±1	1%±1	0.5%±1	0.2%±1	0.5%±1	1%±1
100Hz	79.57 pF ∫ 159.1 pF	159.1 pF ∫ 2.121 nF	1.212 nF ∫ 15.91 nF	15.91 nF ∫ 159.1 μF	159.1 μF ∫ 1591 μF	1591 μF ∫ 15.91mF
	2%±1	1%±1	0.5%±1	0.2%±1	0.5%±1	1%±1
120Hz	66.31pF ∫ 132.6pF	**132.6**pF ∫ 1.768nF	1.768nF ∫ 13. 26nF	13.26nF ∫ 132. 6μF	132. 6μF ∫ 1326μF	1326μF ∫ 13.26mF
	2%±1	1%±1	0.5%±1	0.2%±1	0.5%±1	1%±1
1KHz	7. 957 pF ∫ 15.91 pF	15.91 pF ∫ 212.1 pF	212.1 pF ∫ 1.591 nF	1.591 nF ∫ 15.91 μF	15.91 μF ∫ 159.1 μF	159.1 μF ∫ 1.591 mF
	2%±1	1%±1	0.5%±1	0.2%±1	0.5%±1	1%±1
10KHz	0. 795 pF ∫ 1.591 pF	1.591 pF ∫ 21.21 pF	21.21 pF ∫ 159.1 pF	159.1 pF ∫ 1.591 μF	1.591 μF ∫ 15.91 μF	15.91 μF ∫ 159.1 μF
	5%±1	2%±1	0.5%±1	0.2%±1	0.5%±1	1%±1
100KHz	NA	0.159 pF ∫ 2.121 pF	2.121 pF ∫ 15.91 pF	15.91 pF ∫ 159.1 nF	159.1 nF ∫ 1.591 μF	1.591 μF ∫ 15.91 μF
	NA	5%±1	2%±1	0.4%±1	2%±1	5%±1
500KHz	NA	0.159 pF ∫ 2.121 pF	2.121 pF ∫ 15.91 pF	15.91 pF ∫ 31.91 nF	31.91 nF ∫ 319.1 nF	319.1 n F ∫ 3.191 μF
	NA	10%±1	5%±1	1%±1	5%±1	10%±1
1MHz	NA	0.079 pF ∫ 1.111 pF	1.111 pF ∫ 7.999 pF	7.999 pF ∫ 15.91 nF	15.91 nF ∫ 159.1 nF	159.1 nF ∫ 1.591 μF
	NA	20%	10%±1	2%±1	10%±1	20%±1

L Accuracy：						
20Hz	159.3 KH ∫ 79.55 KH	79.55 KH ∫ 5965 H	5965 H ∫ 795.5 H	795.5 H ∫ 79.55 mH	79.55 mH ∫ 7.955 mH	7.955 mH ∫ 79.55 μH
	2%±1	1%±1	0.5%±1	0.2%±1	0.5%±1	1%±1
100Hz	31.83 KH ∫ 15.91 KH	15.91 KH ∫ 1193H	1193H ∫ 159. 1 H	159. 1 H ∫ 15. 91 mH	15. 91 mH ∫ 1.5 91 mH	1.591 mH ∫ 159. 1μH
	2%±1	1%±1	0.5%±1	0.2%±1	0.5%±1	1%±1
120Hz	26.52KH ∫ 13. 26KH	**13. 26**KH ∫ 995H	995H ∫ 132. 6H	132. 6H ∫ 13. 26mH	13. 26mH ∫ 1.326mH	1.326mH ∫ 132. 6μH
	2%±1	1%±1	0.5%±1	0.2%±1	0.5%±1	1%±1
1KHz	31. 83 KH ∫ 1. 591 KH	1. 591 KH ∫ 119.3 H	119.3 H ∫ 15. 91 H	15. 91 H ∫ 1. 591 mH	1. 591 mH ∫ 159.1 μH	159.1 μH ∫ 15. 91 μH
	2%±1	1%±1	0.5%±1	0.2%±1	0.5%±1	1%±1
10KHz	318.3H ∫ 159. 1 H	159. 1 H ∫ 11.93H	11.93H ∫ 1. 591 H	1. 591 H ∫ 159. 1 μH	159. 1 μH ∫ 15.91 μH	15.91 μH ∫ 1. 591 μH
	5%±1	2%±1	0.5%±1	0.2%±1	0.5%±1	1%±1
100KHz	31. 83 H ∫ 15. 91 H	15. 91 H ∫ 1.193 H	1. 193H ∫ 159. 1 mH	159. 1 mH ∫ 15. 91 μH	15.91 μH ∫ 1. 591 μH	1.591 μH ∫ 0. 159 μH
	NA	5%±1	2%±1	0.4%±1	2%±1	5%±1
500KHz	NA	NA	32.26 mH ∫ 6.363 mH	6.363 mH ∫ 3.181 μH	3.181 μH ∫ 0.318 μH	0.318 μH ∫ 0.031 μH
	NA	NA	5%±1	1%±1	5%±1	10%±1
1MHz	NA	NA	16.13 mH ∫ 3.181 mH	3.181 mH ∫ 1.591 μH	1.591 μH ∫ 0.159 μH	0.159 μH ∫ 0. 015 μH
	NA	NA	10%±1	2%±1	10%±1	20%±1

D Accuracy：						
| Zx | / Freq.	20M ∫ 10M (Ω)	10M ∫ 750K (Ω)	750K ∫ 100K (Ω)	100K ∫ 10 (Ω)	10 ∫ 1 (Ω)	1 ∫ 0.1 (Ω)
20Hz	±0.020	±0.010	±0.005	±0.002	±0.005	±0.010
100Hz						
120Hz						
1KHz						
10KHz	±0.050	±0.020				
100KHz	NA	±0.050	±0.020	±0.004	±0.020	±0.050
500KHz	NA	NA	NA	±0.01	±0.050	±0.10
1MHz	NA	NA	NA	±0.02	±0.10	±0.200

Θ Accuracy：						
| Zx | / Freq.	20M ∫ 10M (Ω)	10M ∫ 750K (Ω)	750K ∫ 100K (Ω)	100K ∫ 10 (Ω)	10 ∫ 1 (Ω)	1 ∫ 0.1 (Ω)
20Hz	±1.046	±0.523	±0.216	±0.105	±0.261	±0.523
100Hz						
120Hz						
1KHz						
10KHz	±2.615	±1.046				
100KHz	NA	±2.615	±1.046	±0.209	±1.046	±2.615
500KHz	NA	NA	NA	±1.001	±5.005	±10.01
1MHz	NA	NA	NA	±2.001	±10.01	±20.01

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